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Progress Letter No. 12

System 3

Contract No. A-101

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(Results of Thermal Tests Appended)

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1-0. GENERAL.

1-1. During the present report period construction of the prototype system was completed and the major effort was expended in evaluating, refining, and flight-testing the prototype system, and on expediting the production of the first systems to be delivered.

2-0. SYSTEM DEVELOPMENT.

2-1. A method of adjusting the lock-on duration has been added to System 3. The lock-on duration may now be controlled by inserting a resistor of appropriate value into a clip. By this means, the lock-on duration can be set to any value between a minimum of 50 milliseconds and a maximum of two minutes.

2-2. System tests indicated the presence of spurious responses. These were reduced by adding decoupling filters, by improved shielding, and by controlling local-oscillator voltages more carefully. The presence of spurious signals required that the lock-on sensitivity levels be raised during the test flights described below. Lock-on was adjusted to function with a minimum input signal, averaging about ten microvolts. It is expected that further work will result in an increase of the lock-on sensitivity toward the design goal of a three-microvolt lock-on level for all channels.

2-3. Laboratory operating tests of subassemblies were made at low and high temperatures. At the low end of the temperature scale, the operation of some transistorized flip-flops became faulty at component temperatures of -40°C . These reverted to normal operation when the temperature was subsequently raised. Since under normal operating conditions sufficient self-heating of the receiver unit occurs and maintains component temperatures

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above 0°C, no difficulty is anticipated due to low temperatures. At the high end of the temperature scale, the transistorized circuits malfunctioned at component (passive) temperatures of 160°C. Since system tests indicate maximum temperatures of 107°C, a margin of safety exists.

2-4. Servicing information is being compiled on the system. Typical oscilloscope displays have been photographed at a number of test points on the various assemblies. These will appear in the System 3 Instruction Guide.

3-0. FLIGHT TEST PROGRAM.

3-1. Three flight tests in the type C-47 aircraft have been concluded. In the initial flight of this series, emphasis was placed on temperature measurements and mechanical characteristics. (See results of thermal tests appended.) Two additional flights were made in which a more comprehensive evaluation of both mechanical and electrical characteristics was made. Although the lock-on sensitivity of several r-f channels was reduced on the first two flights because of the presence of some spurious responses, the results of the flight tests were generally favorable in all other respects.

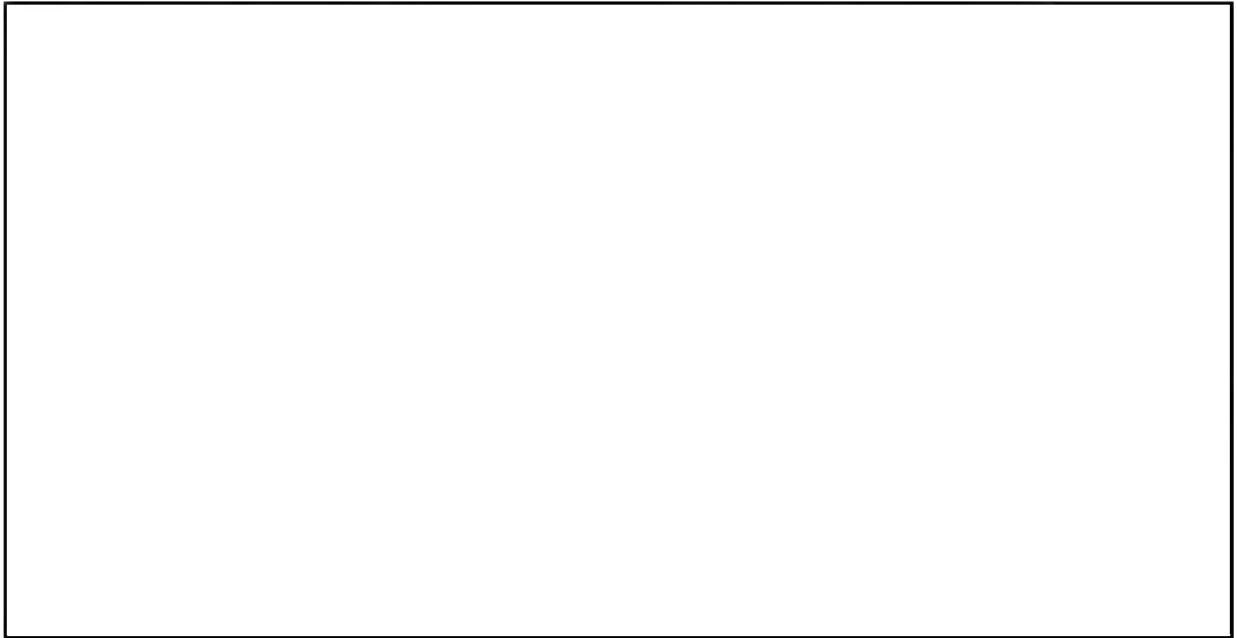
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4-0. TEST SET.

4-1. The breadboard model of the test set has been completed, and the power supply unit has been constructed in finished form. The layout of the r-f signal generator unit has been completed and its construction is underway. The counter unit is presently undergoing mechanical design. The first deliverable test set is scheduled to be completed on 3 August 1956.

5-0. PRODUCTION OF SYSTEM 3.

5-1. Emphasis is being placed on the rapid completion of the initial two systems to be used in actual field operations. All encapsulated components have been assembled. Engineering drawings have been released for production of the sweep assembly, and the release of drawings for remaining subassemblies is imminent. Except for some etched boards, all parts for the initial two systems have been procured. The initial two systems are scheduled to be completed on 8 August 1956.

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SECRET6-0. SYSTEM 3A.

6-1. System 3A is the designation given to the modification of System 3 in which the scan of the system is restricted to any three, or any six of the 144 spectrum divisions into which the total 50 megacycle frequency range of System 3 is divided. This modification is effected, during field use, by the replacement of the second local-oscillator assemblies by substitute plug-in assemblies. The basic design of this new assembly has been formulated, and includes a rotary wafer switch which is used to select either one or two of the sixteen second-local-oscillator crystals present on each assembly. In addition, this assembly includes a switch to permit operation with one crystal, or with any two adjacent crystals; and a switch to gate the desired r-f head. Construction of the first breadboard model has begun. Prototype models are scheduled to be completed on 15 September 1956.

7-0. PLANNING.

7-1. During the coming report period, the major effort will be directed toward the following objectives:

- a. completion of development work on System 3 -- The principal task, here, is to reduce spurious responses.
- b. production of the initial two deliverable systems
- c. completion of the first deliverable System 3 test set
- d. completion of the pre-prototype breadboard model of System 3A
- e. completion of all flight testing

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Preliminary Tests of System 3 Cooling

System 3 (and 3A) is provided with essentially two distinct means of cooling which may be described as follows:

- a. A method in which the dominant heat transfer is by more or less continuous conduction through metal paths extending from the heat producing components to the outer skin structure of the aircraft -- The heat transfer from the skin is, of course, by convection to the atmosphere, which is the ultimate sink. This method will be used during normal flight operation of the receiver.
- b. A method in which the dominant heat transfer is by forced air convection effected by means of a portable blower -- By means of suitable rubber hose connections, the space within the top cover is pressurized by the air delivered from the blower. The cover serves as a plenum chamber to distribute the cooling air which passes through the chassis and over the components. The air is then discharged through a suitable opening in the bottom cover. This system is to be used during ground checking of the receiver in the aircraft, and during bench servicing.

The two systems described have been given preliminary field tests in the type C-47 laboratory airplane. A summary tabulation of the results appears below and these appear to be satisfactory. Inasmuch as under actual flight conditions, skin temperatures are expected to be 50 to 60 degrees Centigrade less than the results show, the various component temperatures observed will be reduced by a like amount. For this reason, a column of corrected values, based on this fact, is listed.

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Test results clearly indicate that the blower has ample capacity to permit the System to operate safely under severe conditions of altitude (of the base site), air, temperature, and dust. Temperatures corrected for a high-elevation base site on a very hot summer day, are given. The assumed conditions are also indicated.

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Test Results of
The Conductive Method of Cooling
(Cooling During Flight)

Date: June 13, 1956 Time: 1700 to 1930 (approximately)

Flight: South from Los Angeles, California, to approximately
25 miles north of San Diego, California, and return

Item	Location of Thermocouple(s)	Terminal (Equilibrium) Temperature	
		Degrees Centigrade	
		As Observed	Corrected to estimated actual flight conditions
1	Center of main chassis plate	89	37
2	Tube shield of second local-oscillator assembly	109	57
3	Tube shield of third local-oscillator assembly	104	52
4	Resistor shield of third local-oscillator assembly	107	55
5	Tube flange of preamplifier	71	19
6	Tube shield of i-f assembly	98	46
7	Tube shield of r-f assembly, bands 3, 5, 8	80	28
8	Power supply rectifiers	62	10
9	Power supply chokes and transformer	68	16
10	Aircraft skin adjacent to receiver	32	-20
11	Edge (flange) of chassis plate	48	-4

Notes on above summary:

The receiver was mounted in box bracket similar to the bracket to be used in the operational aircraft. The material was 1/8 inch thick 2S aluminum alloy mounted in a fuselage window cut out in the skin so as to be directly exposed to the slip stream.

The corrections are based on an assumed skin temperature of minus 20°C as indicated by item 10.

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Test Results of
Blower Cooling
(Forced-Air Cooling During Ground Tests)

Date: July 3, 1956

Time: 1100 to 1230 (approximately)

Place: C-47 test airplane at Los Angeles

Item	Location of Thermocouple(s)	Terminal (Equilibrium) Temperature Degrees Centigrade	
		As Observed	Corrected as noted below
1	Center of main chassis plate	40	76
2	Tube shield of second local-oscillator assembly	45	81
3	Tube shield of third local-oscillator assembly	43	69
4	Resistor shield of third local-oscillator assembly	50	76
5	Air of i-f assembly	41	77
6	Tube shield of i-f assembly	45	81
7	Aircraft skin adjacent to receiver	34	70
8	Edge (flange) of chassis plate	36	72
9	Air inlet to blower	27	49
10	Air discharge from blower	41	67
11	Mean rise through blower and receiver	14	18

Notes on above summary:

The corrected temperature values are based on the following assumptions:

- a. An altitude at test site of 5000 feet above sea level.

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b. An atmospheric (hence blower air inlet) temperature of 49°C (120°F).

c. Test is conducted in shade under awning or other similar structure thereby eliminating sun load. It should be noted, however, that with the aircraft in strong sunlight, the corrected terminal temperatures would probably be increased by less than three degrees centigrade.

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